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ABSTRACT

Entrance scores on the Mathematics Achievement Test, Level I, and Scholastic Aptitude Test (verbal and mathematical), and high school rank for 2,189 students entering engineering as freshmen at The University of Texas at Austin during the years 1974-1977 were used in regression equations as predictors of academic achievement and retention for ethnic (Black, Mexican-American, Anglo) and sex breakdowns. The Mathematics Achievement Test correlated more highly with academic achievement than the other entrance measures among all ethnic and sex groups. The use of freshman year grade point average as a predictor improved prediction of retention among ethnic minorities and Anglo male engineering students over college entry predictors alone. While less useful in predicting retention among women, freshman year achievement monitoring could provide the basis for a counseling and support system to enhance the retention of capable women in engineering. The first-year grade point average appears to be as efficient a predictor as the engineering curriculum grade-point average (mathematics, physics, and engineering mechanics course grades, combined) for use in a predictive equation for retention. (Author/CTM)

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# ETHNICITY AND SEX DIFFERENCES IN USE OF COLLEGE ENTRANCE EXAMINATIONS, MATHEMATICS ACHIEVEMENT, AND HIGH SCHOOL RANK AS PREDICTORS OF PERFORMANCE AND RETENTION AMONG ENGINEERING STUDENTS

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The importance of mathematical skill to student success in engineering has been well documented (Fowler, Jong, & Roger, 1976; Snyder & Merriam, 1978; Troutman, 1978). Physics and engineering mechanics are other important content areas for all students in engineering, although less frequently investigated by researchers. The level of student achievement in mathematics, engineering mechanics, and physics coursework can be considered to be the the essential component in developing a supportive foundation for future engineering specialization, irrespective of any ethnic or sex differences. A combination of these courses into one academic block may be referred to as a basic engineering curriculum grade-point average (ENG/GPA). The prediction of successful achievement in such a basic engineering curriculum and of retention in the engineering program becomes the natural focus of study in most schools of engineering. Consequently, ethnic and sex distinctions in prediction of academic success and retention in engineering also become considerations. Studies of differential patterns of success and retention in large groups of engineering students are needed for guidance purposes, as well as for recruitment of qualified minorities and women into engineering.

The literature bears witness to the fact that many studies of engineering student success have been conducted using traditional predictors of standardized college entrance aptitude tests and high school rank or grades. Unfortuately, studies of both engineering students and of university students in general reveal conflicting results as to the efficacy of these individual predictors.

Price and Kim (1976) and Troutman (1978) found college entrance aptitude examinations to be the best predictor of college achievement among students in general, while Lavin (1965), Kendrick and Thomas (1970), Larson and Scontrino (1976) and Lunneborg (1977) found high school grades to be more useful. The literature becomes even more complex in analyzation of the use of these

predictors with specific ethnic groups and men and women, separately. The issue of test bias, in relation to attempts to develop predictive equations for selection purposes, has resulted in much discussion of the need for "culture-fair" models or procedures to be used with minorities. The investigation of such models has commanded a greater share of the literature than the comparison of particular predictors for different ethnic and sex groups, despite repeated findings of significant mean differences on entrance measures for different groups.

This report is directed toward discussion of the efficacy, for ethnic and sex minorities, of the predictors available at time of entry to college, including a standardized achievement measure in mathematics and performance in the early engineering foundation courses. In general, high school rank (HSR) has been found to be less successful as a predictor of college achievement for ethnic minorities than for Anglo students (Munday, 1965; Peterson, 1968; Farver, Sedlacek, & Brooks, 1975; Lowman & Spuck, 1975). Academic achievement by women seems to be more predictable on the basis of aptitude examinations than achievement by males (Seashore, 1962; Lavin, 1965; Stanley & Porter, 1967; Khan, 1973; Fincher, 1974), yet, Linn (1973) and Durio and Kildow (in print) also found achievement in women to be underpredicted. They found the average earned grade-point of women was higher than that predicted by aptitude tests, although male and female regression slopes were similar. Thus, use of the male criteria for selection might prevent many qualified women from entering engineering, traditionally considered to be a male field. Similar constraints may operate among ethnic minorities. The use of different selection equations for ethnic minorities and women is a debatable issue, but the need to study continuously these groups as separate entities is supported strongly in the literature (Dittmar, 1977). Due to small samples of ethnic and female minorities, prediction patterns often appear inconsistent from year to year.

While no preexisting variable or measure can accurately predict future performance levels of all students, the inclusion of a standardized mathematics achievement test in prediction of engineering success seems warranted (Durio, Kildow, & Slover, 1980). Mathematical skill is an integral part of the engineering curriculum. It might be argued that there is little distinction between standardized aptitude and achievement measures in mathematics, but the results from a study of 1,749 engineering students at The University

of Texas at Austin suggests otherwise, for the mathematics achievement measure correlated more highly with all areas of later academic achievement than scholastic aptitude tests (Durio, et al., 1980). In the study to be reported here, the use of an achievement measure in mathematics also proved to be of significant predictive value across different ethnic and sex groups.

## Procedures

Students entering engineering at U.T. Austin as freshmen during the fall semesters of the years 1974 through 1977 were given the Mathematics Achievement Test, Level I (College Entrance Examination Board), as an aid to appropriate placement in pre-calculus or calculus sequences of mathematics instruction. (This test covers the typical content taught in three years of high school mathematics coursework.) In addition, the College Board Scholastic Aptitude Test, Verbal and Mathematical scores (SAT-V and SAT-M), and high school rank in class (HSR) were available from the students' admissions records. High school rank was computed by the formula 1-(rank in class/size of class) x 100. Academic performance for all registered courses as well as records of attrition and retention were maintained for students through the fall semester of 1978. Three patterns of retention and five patterns of attrition were identified, but for purposes of this analysis, a dichotomy was formed by combining the five attrition patterns into one group and the three retention patterns into another group. Mathematics, physics, and engineering mechanics course grade-point averages were combined to form an achievement index for the basic engineering curriculum (ENG/GPA), and first year grade-point averages (FYR/GPA) were maintained for all students.

Forward stepwise multiple regression statistical procedures were used to analyze the usefulness of the Mathematics Achievement Test, Level I (Math I), SAT-M, SAT-V, and HSR to the prediction of academic success for the ENG/GPA criterion for Black, Anglo, and Mexican-American students, separately. Sample sizes were too small or in some cases nonexistent (i.e., no Black females) to be able to break down ethnic groups by sex. Consequently, men and women were combined across ethnic categories. The same techniques were used for predicting the criterion of group membership in either attrition or re-

tention categories for each ethnic group and for men and women, with Math I, SAT-M, SAT-V, and HSR as entry data predictors, along with the added predictors of academic performance in the ENG/GPA course block in one equation and FYR/GPA in another equation, for prediction of retention.

## Results

Tables 1 and 2 compare the means and standard deviations of all scholastic aptitude and achievement variables for each ethnic and sex group, while Figures 1 and 2 graph academic achievement comparisons within ethnicity and sex. There were significant mean differences on all college entrance scores among ethnic groups. Between the sexes, there were significant mean differences on entrance scores, with the exception of Math I. In general, Anglos surpassed minority students and women surpassed men. Tables 3 and 4 provide correlation coefficients for college entry measures and later grade-point averages for ethnic and sex groups.

Tables 5-9 reveal that the Math I measure emerged as the primary predictor of the engineering curriculum GPA in all groups. However, the amount of variance being accounted for by this measure varied sharply from one ethnic and sex group to another, as did coefficients of multiple correlation and determination when the SAT-M, SAT-V, and HSR predictors were combined with the Math I predictor. These combined measures contributed less to the prediction of success among ethnic minorities than among Anglos (91 Black students, $R = .504$, $R^2 = .254$; 194 Mexican-American students, $R = .426$, $R^2 = .181$; 1,438 Anglo students, $R = .561$, $R^2 = .314$). Consistent with the literature, college entry measures accounted for more of the variance in performance among women than men (1,514 male students, $R = .558$, $R^2 = .311$; 235 female students, $R = .600$, $R^2 = .360$). The correction for shrinkage formula $R^2 = 1-(1-R^2)x(\frac{N-1}{N-K})$ is supplied for regression equations with more than one entering predictor to estimate the effects of cross validation. However, when using a stepwise solution, the selection procedures applied to the independent variables and even more to capitalization on chance (Kerlinger & Pedhazur, 1973).

Tables 10-14 show that early academic achievement in the engineering curriculum proved to be the best single predictor of retention in engineering for

all groups. [When college entry data were used alone as predictors of retention, less than 7% of the variance was accounted for across all groups. Forecasting efficiency increases were more than 50% by inclusion of early college achievement (E formula, Guilford, 1965, p. 400).] The amount of variance being accounted for was not too dissimilar among ethnic categories in prediction of retention (91 Black students, $R = .382$, $R^2 = .146$; 194 Mexican-American students, $R = .456$, $R^2 = .208$; 1,438 Anglo students, $R = .431$, $R^2 = .186$). However, much more variance was accounted for among men than among women in retention (1,514 male students, $R = .476$, $R^2 = .227$; 236 female students, $R = .201$, $R^2 = .040$).

Tables 15-19 supply this same information using FYR/GPA with entry measures as a predictor of retention (91 Black students, $R = .402$, $R^2 = .162$; 195 Mexican-American students, $R = .456$, $R^2 = .208$; 1,448 Anglo students, $R = .407$, $R^2 = .166$; 1,525 male students, $R = .449$, $R^2 = .201$; 235 women, $R = .273$, $R^2 = .075$). FYR/GPA is thus as effective as the basic engineering GPA in predicting retention.

## Discussion

The predictability of academic success among ethnic groups differed, in that basic engineering curriculum grade-point averages were better explained by college entrance scores among Anglo and Black students than among Mexican-American students. Academic success was more predictable among women than men on the basis of college entry measures, also. The Mathematics Achievement Test, Level I, correlated more highly with engineering achievement than did other college entry measures for all students, which emphasizes the usefulness of this measure for engineering schools.

In general, it can be said that retention in engineering was difficult to predict on the basis of only college entrance scores for all students. The prediction of retention for students, regardless of ethnicity or sex, is invariably more difficult than the prediction of academic performance. Attrition and retention may be affected by variables other than academic aptitude, such as personality characteristics, socio-economic factors, and motivational factors. The amount of variation in retention that could be accounted for by

college entry measures alone resulted in less than 7% for any ethnic or sex group. When achievement in the early engineering courses (combined mathematics, physics, and engineering mechanics grade-point average or ENG/GPA) was included as a predictor of retention, it became the significant predictor of retention for all ethnic and male student groups. Similarly, when first year grade-point average achievement (FYR/GPA) was used with college entry measures to predict retention, FYR/GPA became the most important predictor of the retention differences among Black, Mexican-American, Anglo, and all male engineering students. Thus, the monitoring of progress in the first year for ethnic minorities and Anglo males is important to predicting retention.

However, the retention of women in engineering was far less predictable than that of men when traditional college entrance measures and/or early academic performance were used as predictors. The differences between the sexes in squared multiple correlation indices ($R^2$) for retention were quite large. This is interesting, considering that academic achievement among engineering women was more predictable than that of men on the basis of college entrance scores. Similar findings have been reported in the literature concerning the better achievement predictability of women, but few writings are available on the retention characteristics of women in engineering. Durio and Kildow (in print) explored the characteristics of women leaving engineering and found the majority of them to be sufficiently qualified to remain in engineering, as evidenced by the mean scores on entrance measures and mean achievement of the female attrition group. Male students leaving engineering were more likely to do so for reasons of academic failure. Female engineering students, in general, represented a more restricted ability range than men; this difference tended to lower the multiple correlation coefficient for retention among women. Only women with high mathematical ability are likely to enter engineering, while men with moderate levels of mathematical skill may still feel confident enough to enter engineering. For the purpose of developing a support system to aid in their retention, the monitoring of female student progress might be better combined with attempts to discover the reasons qualified women want to transfer out of engineering at U.T. Austin and other universities.

There were similar percentages of attrition within ethnic minority categories in engineering at U.T. Austin. Attrition rates within this sample of engineering students were 48.3% for Blacks and 48.4% for Mexican-Americans as opposed to 36.4% for Anglos. Female attrition rates did not differ quite as much from male attrition rates as ethnic minorities did from Anglo students: 37.9% males and 41.1% women. In general, ethnic minority students dropped out of engineering and left the University rather than transferring to other majors, while women transferred to other majors and remained at the University.

It must be emphasized that the small numbers of students in certain of the minority student samples may contribute to a lack of stability in the order of specific predictors for the achievement and retention criteria. It should be further emphasized that these predictive equations have not been cross-validated on new samples of students, although a correction for bias is supplied when more than one variable entered the equation. In future samples of minority students, subsequent analyses might reveal a differing order of emerging predictors from that seen in these equations.

## Conclusions

For counseling and prediction purposes as well as for placement in appropriate mathematics courses, this study supports the usefulness of a mathematics achievement test upon entry to engineering. The monitoring of early student progress by ethnic and sex groupings is recommended. Early academic achievement was a more effictive predictor of retention among ethnic minorities and Anglo male engineering students than were college entry measures alone. While less useful in predicting retention among women, early achievement monitoring could provide the basis for a counseling and support system to enhance the retention of capable women in engineering. For use in a predictive equation for retention, compiling a first year grade-point average provides as efficient a predictor as compiling an engineering curriculum grade-point average. Furthermore, FYR/GPA is more easily compiled than an engineering grade-point average, which requires identification of courses of interest, and is complicated by students' failure to enroll in all the courses in the same time sequence.

Table 1

Comparisons, by Ethnicity, of Means and Standard Deviations of Aptitude Scores and Academic Performance Measures for 2,189 Freshman Engineering Students Who Entered U.T. Austin in the Fall Semesters of 1974-1977

| Aptitude/ Academic Performance Variable | Ethnicity | | | | | | Total | | p |
|---|---|---|---|---|---|---|---|---|---|
| | Black | | Mexican-American | | Anglo | | | | |
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | |
| Math I | 506 (N=104) | 75 | 550 (N=213) | 74 | 611 (N=1573) | 89 | 598 (N=1890) | 92 | <.001 |
| SAT-V | 427 (N=120) | 82 | 444 (N=249) | 89 | 512 (N=1809) | 89 | 499 (N=2178) | 93 | <.001 |
| SAT-M | 500 (N=120) | 68 | 540 (N=249) | 74 | 614 (N=1809) | 81 | 599 (N=2178) | 86 | <.001 |
| HSR | 85.5 (N=105) | 15.0 | 85.6 (N=229) | 13.8 | 80.0 (N=1664) | 17.1 | 80.90 (N=1998) | 16.81 | <.001 |
| M/GPA | 1.94 (N=119) | 1.08 | 2.08 (N=244) | 1.12 | 2.53 (N=1753) | 1.13 | 2.44 (N=2116) | 1.14 | <.001 |
| PHY/GPA | 2.21 (N=98) | 1.37 | 2.8 (N=215) | 1.33 | 2.66 (N=1607) | 1.19 | 2.58 (N=1920) | 1.23 | <.001 |
| EM/GPA | 1.66 (N=55) | 1.13 | 2.02 (N=128) | 1.04 | 2.51 (N=1196) | 1.12 | 2.43 (N=1379) | 1.13 | <.001 |
| ENG/GPA | 1.86 (N=120) | 1.05 | 1.94 (N=247) | 1.06 | 2.46 (N=1795) | 1.08 | 2.37 (N=2162) | 1.09 | <.001 |
| FYR/GPA | 2.05 (N=120) | 0.81 | 2.17 (N=249) | 0.87 | 2.62 (N=1815) | 0.90 | 2.58 (N=2184) | 0.91 | <.001 |
| CUM/GPA | 1.90 (N=120) | 0.71 | 2.24 (N=250) | 0.76 | 2.55 (N=1819) | 0.86 | 2.48 (N=2189) | 0.86 | <.001 |

Math I = Mathematics Achievement Test, Level I
SAT-V = Scholastic Aptitude Test-verbal
SAT-M = Scholastic Aptitude Test-Mathematical
HSR = High School Rank
M/GPA = Mathematics Grade-point Average
PHY/GPA = Physics Grade-point Average
EM/GPA = Engineering Mechanics Grade-point Average
ENG/GPA = Engineering Curriculum Grade-point Average
FYR/GPA = First Year Grade-point Average
CUM/GPA = Cumulative Grade-point Average

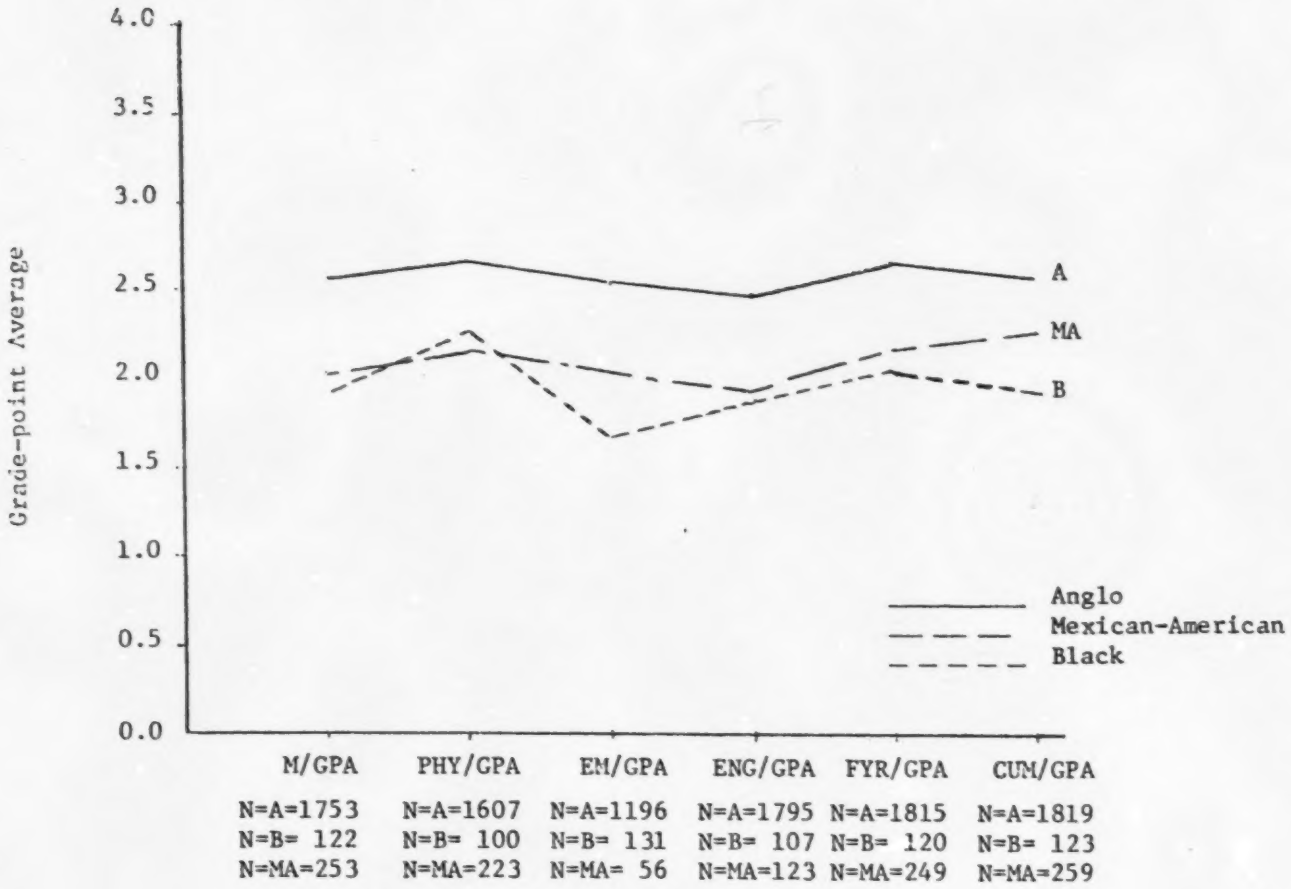


Figure 1: Comparison of Academic Achievement by Subject and Ethnicity of Freshman Engineering Students Who Entered U.T. Austin in the Fall Semesters, 1974-1977

M/GPA = Mathematics Grade-point Average
PHY/GPA = Physics Grade-point Average
EM/GPA = Engineering Mechanics Grade-point Average
ENG/GPA = Engineering Curriculum Grade-point Average
FYR/GPA = First Year Grade-point Average
CUM/GPA = Cumulative Grade-point Average

Table 2

Comparisons, by Sex, of Mean Aptitude Scores and Academic Performance of 2,226 Freshman Engineering Students Who Entered U.T. Austin in the Fall Semesters of 1974-1977

| Aptitude/ Academic Performance Variable | Sex | | | | Total | | p |
|---|---|---|---|---|---|---|---|
| | Male | | Female | | | | |
| | Mean | S.D. | Mean | S.D. | Mean | S.D. | |
| Math I | 599 (N=1667) | 93 | 594 (N=254) | 89 | 599 (N=1921) | 60 | .346 |
| SAT-V | 496 (N=1939) | 92 | 518 (N=273) | 99 | 499 (N=2212) | 94 | <.001 |
| SAT-M | 601 (N=1939) | 86 | 589 (N=273) | 89 | 599 (N=2212) | 87 | .033 |
| HSR | 79.85 (N=1772) | 17.1 | 89.03 (N=254) | 12.1 | 81.00 (N=2026) | 16.8 | <.001 |
| M/GPA | 2.42 (N=1889) | 1.14 | 2.71 (N=263) | 1.08 | 2.46 (N=2152) | 1.14 | <.001 |
| PHY/GPA | 2.57 (N=1721) | 1.23 | 2.75 (N=232) | 1.20 | 2.59 (N=1953) | 1.23 | <.030 |
| EM/GPA | 2.42 (N=1257) | 1.15 | 2.50 (N=146) | 1.03 | 2.43 (N=1403) | 1.15 | .436 |
| ENG/GPA | 2.35 (N=1929) | 1.09 | 2.56 (N=270) | 1.05 | 2.38 (N=2199) | 1.09 | <.004 |
| FYR/GPA | 2.52 (N=1949) | .91 | 2.74 (N=272) | .89 | 2.55 (N=2221) | .91 | <.001 |
| CUM/GPA | 2.46 (N=1953) | .86 | 2.65 (N=273) | .82 | 2.49 (N=2226) | .86 | <.001 |

Math I = Mathematics Achievement Test, Level I
SAT-V = Scholastic Aptitude Test-Verbal
SAT-M = Scholastic Aptitude Test-Mathematical
HSR = High School Rank
M/GPA = Mathematics Grade-point Average
PHY/GPA = Physics Grade-point Average
EM/GPA = Engineering Mechanics Grade-point Average
ENG/GPA = Engineering Curriculum Grade-point Average
FYR/GPA = First Year Grade-point Average
CUM/GPA = Cumulative Grade-point Average

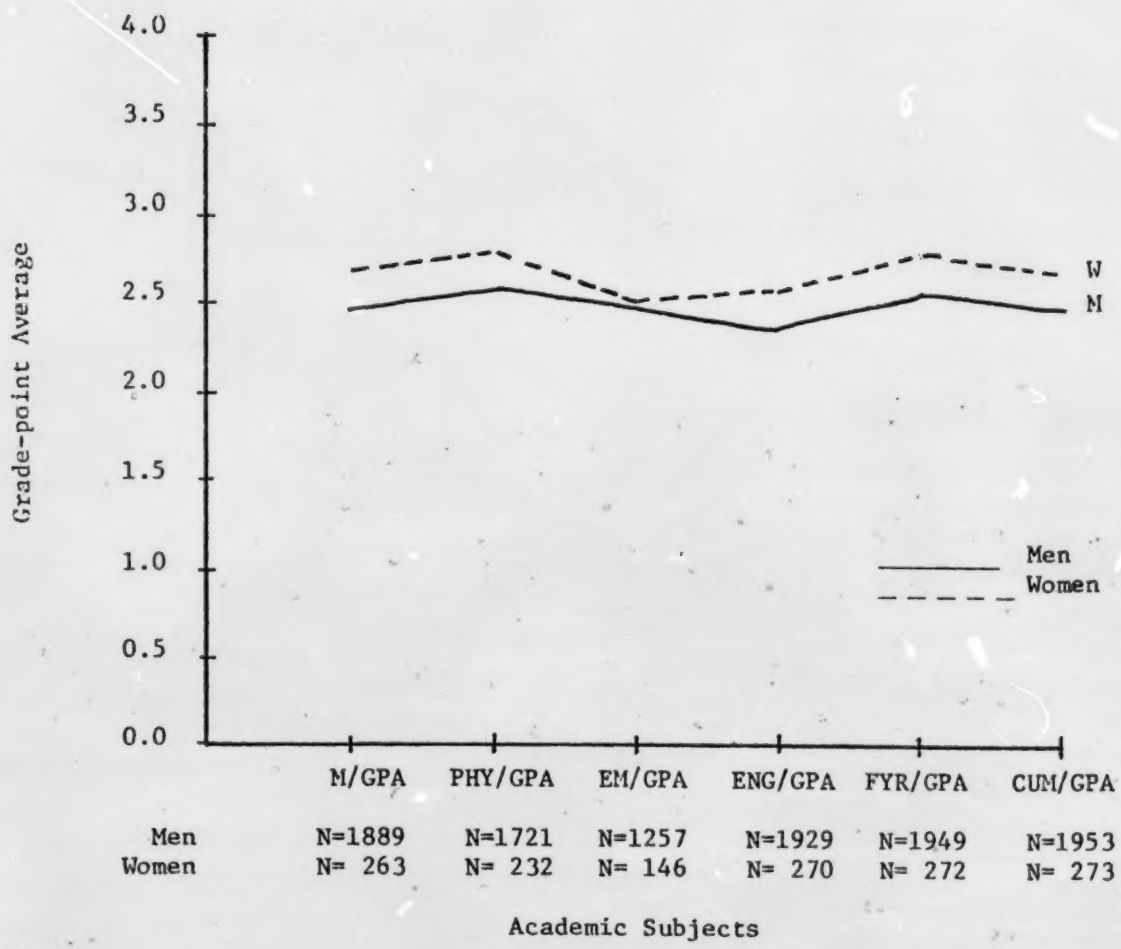


Figure 2: Comparison of Academic Achievement, by Subject and Sex, of 2,226 Freshman Engineering Students Who Entered U.T. Austin in the Fall Semesters, 1974-1977.

M/GPA = Mathematics Grade-point Average
PHY/GPA = Physics Grade-point Average
EM/GPA = Engineering Mechanics Grade-point Average
ENG/GPA = Engineering Curriculum Grade-point Average
FYR/GPA = First Year Grade-point Average
CUM/GPA = Cumulative Grade-point Average

Table 3

Correlation Coefficients Between Mean Aptitude Scores and Academic Performance Measures, by Ethnicity, of 2,189 Freshman Engineering Students Who Entered U.T. Austin in the Fall Semesters of 1974-1977

| Academic Performance Measures | Prior Aptitude/Achievement Measures | | | |
|---|---|---|---|---|
| | Math I | SAT-V | SAT-M | HSR |
| M/GPA | | | | |
| Black | .31*** (N=103) | .02 (N=119) | .24** (N=119) | .24** (N=104) |
| Mexican-American | .38*** (N=208) | -.03 (N=243) | .30*** (N=243) | .28*** (N=224) |
| Anglo | .47*** (N=1528) | .28*** (N=1743) | .41*** (N=1743) | .40*** (N=1602) |
| PHY/GPA | | | | |
| Black | .20** (N=86) | -.15 (N=98) | .20* (N=98) | .23* (N=85) |
| Mexican-American | .23*** (N=188) | .01 (N=214) | .13* (N=214) | .28*** (N=197) |
| Anglo | .35*** (N=1407) | .24*** (N=1598) | .30*** (N=1598) | .31*** (N=1465) |
| EM/GPA | | | | |
| Black | .38** (N=48) | .02 (N=55) | .30* (N=55) | .40** (N=48) |
| Mexican-American | .24** (N=113) | .07 (N=127) | .18* (N=127) | .06 (N=120) |
| Anglo | .42*** (N=1059) | .24*** (N=1190) | .35*** (N=1190) | .31*** (N=1098) |
| ENG/GPA | | | | |
| Black | .36*** (N=104) | -.001 (N=120) | .27*** (N=120) | .24** (N=105) |
| Mexican-American | .40*** (N=211) | .00 (N=246) | .32*** (N=246) | .27*** (N=226) |
| Anglo | .50*** (N=1558) | .30*** (N=1785) | .43*** (N=1785) | .41*** (N=1641) |
| FYR/GPA | | | | |
| Black | .34*** (N=104) | .10 (N=120) | .30*** (N=120) | .39*** (N=105) |
| Mexican-American | .33*** (N=20) | .04 (N=248) | .30*** (N=248) | .26*** (N=228) |
| Anglo | .49*** (N=1569) | .35*** (N=1805) | .42*** (N=1805) | .46*** (N=1660) |
| CUM/GPA | | | | |
| Black | .45*** (N=104) | .09 (N=120) | .34*** (N=120) | .26** (N=105) |
| Mexican-American | .28*** (N=213) | .08 (N=249) | .25*** (N=249) | .30*** (N=229) |
| Anglo | .51*** (N=1573) | .36*** (N=1809) | .44*** (N=1809) | .46*** (N=1660) |

*p<.05, **p<.01, ***p<.001 (differ from r=0)

M/GPA = Mathematics Grade-point Average
PHY/GPA = Physics Grade-point Average
EM/GPA = Engineering Mechanics Grade-point Average
ENG/GPA = Engineering Curriculum Grade-point Average
FYR/GPA = First Year Grade-point Average
CUM/GPA = Cumulative Grade-point Average

Table 4

Correlation of Mean Aptitude Scores and Academic Performance
By 2,212 Male and Female Freshman Engineering Students
Who Entered U.T. Austin in the Fall Semesters
Of 1974-1977

| Academic Performance Measures | Prior Aptitude/Achievement Measures | | | |
|---|---|---|---|---|
| | Math I | SAT-V | SAT-M | HSR |
| M/GPA | | | | |
| Male | .48*** (N=1623) | .25*** (N=1875) | .42*** (N=1875) | .34*** (N=1712) |
| Female | .47*** (N=246) | .32*** (N=263) | .44*** (N=263) | .36*** (N=246) |
| PHY/GPA | | | | |
| Male | .35*** (N=1494) | .21*** (N=1708) | .30*** (N=1708) | .27*** (N=1556) |
| Female | .38*** (N=216) | .27*** (N=232) | .33*** (N=232) | .29*** (N=216) |
| EM/GPA | | | | |
| Male | .44*** (N=1103) | .24*** (N=1248) | .37*** (N=1248) | .27*** (N=1149) |
| Female | .42*** (N=138) | .28*** (N=146) | .41*** (N=146) | .23** (N=134) |
| ENG/GPA | | | | |
| Male | .52*** (N=1652) | .28*** (N=1915) | .45*** (N=1915) | .35*** (N=1748) |
| Female | .52*** (N=252) | .35*** (N=270) | .48*** (N=270) | .34*** (N=252) |
| FYR/GPA | | | | |
| Male | .50*** (N=1663) | .33*** (N=1935) | .45*** (N=1935) | .38*** (N=1768) |
| Female | .51*** (N=253) | .40*** (N=272) | .47*** (N=272) | .44*** (N=253) |
| CUM/GPA | | | | |
| Male | .53*** (N=1667) | .33*** (N=1939) | .46*** (N=1939) | .39*** (N=1772) |
| Female | .53*** (N=254) | .44*** (N=273) | .47*** (N=273) | .44*** (N=254) |

*p=<.05
**p=<.01 (differs from r=0)
***p=<.001

M/GPA = Mathematics Grade-point Average
PHY/GPA = Physics Grade-point Average
EM/GPA = Engineering Mechanics Grade-point Average
ENG/GPA = Engineering Curriculum Grade-point Average
FYR/GPA = First Year Grade-point Average
CUM/GPA = Cumulative Grade-point Average

Table 5

Comparison of Four Variables, Singly and in Combination, as Predictors of Basic Engineering Curriculum Grade-point Averages for 91 Black Freshman Engineering Students Who Entered U.T. Austin in the Fall Semesters of 1974-1977

Y (Criterion Variable to be Predicted): ENG/GPA

| Predictor Variable | r<br>Correlation Coefficient (One predictor variable only) | R<br>Multiple Correlation Coefficient (Set of predictor variables) | $R^2$<br>Square of Multiple Correlation Coefficient | $R^2$ Change<br>Increase with addition of next predictor variable | F-Ratio<br>To test significance of increase in R | p<br>Statistical Significance of Increase (Level of Confidence) |
|---|---|---|---|---|---|---|
| Math I | $r_{YA} = .383$ | $R_{Y \cdot A} = .383$ | .146 | .146 | 15.27 | <.001 |
| HSR | $r_{YB} = .238$ | $R_{Y \cdot AB} = .456$ | .209 | .063 | 6.91 | .010 |
| SAT-V | $r_{YC} = -.049$ | $R_{Y \cdot ABC} = .504$* | .254* | .045 | 5.34 | .023 |
| SAT-M | $r_{YD} = .241$ | $R_{Y \cdot ABCD} = .505$ | .255 | .001 | .02 | .887 |

Predicted ENG/GPA = .0071 Math I + .0155 HSR - .0031 SAT-V - 1.77.

$R_{Y \cdot ABC} = .504$; Standard Error of Estimate = .95.

*Correction for R bias, R = .487; $R^2 = .237$

Table 6

Comparison of Four Variables, Singly and in Combination, as Predictors of Basic Engineering Curriculum Grade-point Averages for 194 Mexican-American Freshman Engineering Students Who Entered U.T. Austin in the Fall Semesters of 1974-1977

Y (Criterion Variable to be Predicted): ENG/GPA

| Predictor Variable | r<br>Correlation Coefficient (One predictor variable only) | R<br>Multiple Correlation Coefficient (Set of predictor variables) | $R^2$<br>Square of Multiple Correlation Coefficient | $R^2$ Change<br>Increase with addition of next predictor variable | F-Ratio<br>To test significance of increase in R | p<br>Statistical Significance of Increase (Level of Confidence) |
|---|---|---|---|---|---|---|
| Math I | $r_{YA} = .390$ | $R_{Y \cdot A} = .390$ | .152 | .152 | 34.41 | <.001 |
| HSR | $r_{YB} = .224$ | $R_{Y \cdot AB} = .426$* | .181* | .029 | 6.88 | .009 |
| SAT-V | $r_{YC} = .058$ | $R_{Y \cdot ABC} = .433$ | .187 | .006 | 1.32 | .252 |
| SAT-M | $r_{YD} = .303$ | $R_{Y \cdot ABCD} = .443$ | .197 | .010 | 2.22 | .138 |

Predicted ENG/GPA = .0050 Math I + .0138 HSR - 1.98. (ENG/GPA = grade-point average for basic courses in mathematics, physics and engineering mechanics.)

$R_{Y \cdot AB} = .426$; Standard Error of Estimate = .94.

*Correction for R bias, R = .420; $R^2 = .177$

Table 7

Comparison of Four Variables, Singly and in Combination, as Predictors of Basic Engineering Curriculum Grade-point Averages for 1,438 Anglo Freshman Engineering Students Who Entered U.T. Austin in the Fall Semesters of 1974-1977

Y (Criterion Variable to be Predicted): ENG/GPA

| Predictor Variable | r<br>Correlation Coefficient (One predictor variable only) | R<br>Multiple Correlation Coefficient (Set of predictor variables) | $R^2$<br>Square of Multiple Correlation Coefficient | $R^2$ Change<br>Increase with addition of next predictor variable | F-Ratio<br>To test significance of increase in R | p<br>Statistical Significance of Increase (Level of Confidence) |
|---|---|---|---|---|---|---|
| Math I | $r_{YA} = .500$ | $R_{Y \cdot A} = .500$ | .250 | .250 | 477.39 | <.001 |
| HSR | $r_{YB} = .416$ | $R_{Y \cdot AB} = .556$ | .309 | .059 | 124.57 | <.001 |
| SAT-M | $r_{YC} = .430$ | $R_{Y \cdot ABC} = .561$* | .314* | .005 | 10.11 | .002 |
| SAT-V | $r_{YD} = .302$ | $R_{Y \cdot ABCD} = .561$ | .315 | .001 | .82 | .366 |

Predicted ENG/GPA = .0038 Math I + .0161 HSR + .0014 SAT-M - 1.96.

$R_{Y \cdot ABC} = .561$; Standard Error of Estimate = .87.

*Correction for R bias, R = .559; $R^2 = .313$

Table 8

Comparison of Four Variables, Singly and in Combination, as Predictors of Basic Engineering Curriculum Grade-point Averages for 1,514 Male Freshman Engineering Students Who Entered U.T. Austin in the Fall Semesters of 1974-1977

Y (Criterion Variable to be Predicted): ENG/GPA

| Predictor Variable | r<br>Correlation Coefficient (One predictor variable only) | R<br>Multiple Correlation Coefficient (Set of predictor variables) | $R^2$<br>Square of Multiple Correlation Coefficient | $R^2$ Change<br>Increase with addition of next predictor variable | F-Ratio<br>To test significance of increase in R | p<br>Statistical Significance of Increase (Level of Confidence) |
|---|---|---|---|---|---|---|
| Math I | $r_{YA} = .515$ | $R_{Y \cdot A} = .515$ | .266 | .266 | 546.95 | <.001 |
| HSR | $r_{YB} = .347$ | $R_{Y \cdot AB} = .553$ | .306 | .040 | 87.29 | <.001 |
| SAT-M | $r_{YC} = .442$ | $R_{Y \cdot ABC} = .558$* | .311* | .005 | 11.76 | .001 |
| SAT-V | $r_{YD} = .282$ | $R_{Y \cdot ABCD} = .558$ | .311 | .000 | .01 | .908 |

Predicted ENG/GPA = .0042 Math I + .0134 HSR + .0015 SAT-M - 2.06. (ENG/GPA = Grade-point average in mathematics, physics, and engineering mechanics.)

$R_{Y \cdot ABC} = .558$; Standard Error of Estimate = .88.

*Correction for R bias, R = .556; $R^2 = .310$

Table 9

Comparison of Four Variables, Singly and in Combination, as Predictors of the Basic Engineering Curriculum Grade-point Averages for 235 Female Freshman Engineering Students Who Entered U.T. Austin in the Fall Semesters of 1974-1977

Y (Criterion Variable to be Predicted): ENG/GPA

| Predictor Variable | r<br>Correlation Coefficient (One predictor variable only) | R<br>Multiple Correlation Coefficient (Set of predictor variables) | $R^2$<br>Square of Multiple Correlation Coefficient | $R^2$ Change<br>Increase with addition of next predictor variable | F-Ratio<br>To test significance of increase in R | p<br>Statistical Significance of Increase (Level of Confidence) |
|---|---|---|---|---|---|---|
| Math I | $r_{YA}$ = .520 | $R_{Y \cdot A}$ = .520 | .270 | .270 | 86.14 | <.001 |
| HSR | $r_{YB}$ = .380 | $R_{Y \cdot AB}$ = .588 | .346 | .076 | 26.80 | <.001 |
| SAT-M | $r_{YC}$ = .488 | $R_{Y \cdot ABC}$ = .600* | .360* | .015 | 5.25 | .023 |
| SAT-V | $r_{YD}$ = .354 | $R_{Y \cdot ABCD}$ = .600 | .360 | .000 | .06 | .806 |

Predicted ENG/GPA = .0037 Math I + .0253 HSR + .0025 SAT-M - 3.30. (ENG/GPA = Grade-point average in mathematics, physics, and engineering mechanics.)

$R_{Y \cdot ABC}$ = .600; Standard Error of Estimate = .86.

*Correction for R bias, R = .595; $R^2$ = .354

Table 10

Comparison of Five Variables, Singly and in Combination, as Predictors of Retention for 91 Black Freshman Engineering Students Who Entered U.T. Austin in the Fall Semesters of 1974-1977

Y (Criterion Variable to be Predicted): Retention

| Predictor Variable | r<br>Correlation Coefficient (One predictor variable only) | R<br>Multiple Correlation Coefficient (Set of predictor variables) | $R^2$<br>Square of Multiple Correlation Coefficient | $R^2$ Change<br>Increase with addition of next predictor variable | F-Ratio<br>To test significance of increase in R | p<br>Statistical Significance of Increase (Level of Confidence) |
|---|---|---|---|---|---|---|
| ENG/GPA | $r_{YA}$ = .382 | $R_{Y \cdot A}$ =.382 | .146 | .146 | 15.22 | <.001 |
| HSR | $r_{YB}$ = .191 | $R_{Y \cdot AB}$ =.396 | .157 | .011 | 1.11 | .294 |
| SAT-V | $r_{YC}$ = .081 | $R_{Y \cdot ABC}$ =.412 | .170 | .013 | 1.38 | .243 |
| Math I | $r_{YD}$ = .172 | $R_{Y \cdot ABCD}$ =.413 | .171 | .001 | .03 | .858 |
| SAT-M | $r_{YE}$ = .135 | $R_{Y \cdot ABCDE}$ =.413 | .171 | .000 | .07 | .799 |

Predicted Retention = .1785 ENG/GPA + 1.20.

$R_{Y \cdot A}$ = .382; Standard Error of Estimate = .47. (55% increase in forecasting efficiency over entry measures alone as predictors.)

Table 11

Comparison of Five Variables, Singly and in Combination, as Predictors of Retention for 194 Mexican-American Freshman Engineering Students Who Entered U.T. Austin in the Fall Semesters of 1974-1977

Y (Criterion Variable to be Predicted): Retention

| Predictor Variable | r<br>Correlation Coefficient (One predictor variable only) | R<br>Multiple Correlation Coefficient (Set of predictor variables) | $R^2$<br>Square of Multiple Correlation Coefficient | $R^2$ Change<br>Increase with addition of next predictor variable | F-Ratio<br>To test significance of increase in R | p<br>Statistical Significance of Increase (Level of Confidence) |
|---|---|---|---|---|---|---|
| ENG/GPA | $r_{YA}$ = .456 | $R_{Y \cdot A}$ =.456 | .208 | .208 | 50.34 | <.001 |
| SAT-M | $r_{YB}$ = .166 | $R_{Y \cdot AB}$ =.457 | .209 | .001 | .21 | .651 |
| Math I | $r_{YC}$ = .163 | $R_{Y \cdot ABC}$ =.459 | .210 | .001 | .42 | .518 |
| HSR | $r_{YD}$ = .128 | $R_{Y \cdot ABCD}$ =.460 | .211 | .001 | .21 | .649 |
| SAT-V | $r_{YE}$ = .048 | $R_{Y \cdot ABCDE}$ =.460 | .211 | .000 | .08 | .775 |

Predicted Retention = .2215 ENG/GPA + 1.09.

$R_{Y \cdot A}$ = .456; Standard Error of Estimate = .45. (55% increase in forecasting efficiency over entry measures alone as predictors.)

Table 12

Comparison of Five Variables, Singly and in Combination, as Predictors of Retention for 1,438 Anglo Freshman Engineering Students Who Entered U.T. Austin in the Fall Semesters of 1974-1977

Y (Criterion Variable to be Predicted): Retention

| Predictor Variable | r<br>Correlation Coefficient (One predictor variable only) | R<br>Multiple Correlation Coefficient (Set of predictor variables) | $R^2$<br>Square of Multiple Correlation Coefficient | $R^2$ Change<br>Increase with addition of next predictor variable | F-Ratio<br>To test significance of increase in R | p<br>Statistical Significance of Increase (Level of Confidence) |
|---|---|---|---|---|---|---|
| ENG/GPA | $r_{YA}$ = .428 | $R_{Y \cdot A}$ =.428 | .183 | .183 | 321.67 | <.001 |
| SAT-V | $r_{YB}$ = .080 | $R_{Y \cdot AB}$ =.431* | .186* | .003 | 4.68 | .031 |
| Math I | $r_{YC}$ = .213 | $R_{Y \cdot ABC}$ =.431 | .186 | .000 | .81 | .368 |
| HSR | $r_{YD}$ = .165 | $R_{Y \cdot ABCD}$ =.432 | .187 | .001 | .13 | .715 |
| SAT-M | $r_{YE}$ = .169 | $R_{Y \cdot ABCDE}$ =.432 | .187 | .000 | .12 | .731 |

Predicted Retention = .2019 ENG/GPA - .0003 SAT-V + 1.30.

$R_{Y \cdot AB}$ = .431; Standard Error of Estimate = .43. (59% increase in forecasting efficiency over entry measures alone as predictors.)

*Correction for R bias, R = .430; $R^2$ = .185

Table 13

Comparison of Five Variables, Singly and in Combination, as Predictors of Retention for 1,514 Male Freshman Engineering Students Who Entered U.T. Austin in the Fall Semesters of 1974-1977

Y (Criterion Variable to be Predicted): Retention

| Predictor Variable | r<br>Correlation Coefficient (One predictor variable only) | R<br>Multiple Correlation Coefficient (Set of predictor variables) | $R^2$<br>Square of Multiple Correlation Coefficient | $R^2$ Change<br>Increase with addition of next predictor variable | F-Ratio<br>To test significance of increase in R | p<br>Statistical Significance of Increase (Level of Confidence) |
|---|---|---|---|---|---|---|
| ENG/GPA | $r_{YA}$ = .476 | $R_{Y \cdot A}$ =.476 | .227 | .227 | 442.83 | <.001 |
| Math I | $r_{YB}$ = .227 | $R_{Y \cdot AB}$ =.476 | .227 | .000 | .86 | .355 |
| SAT-V | $r_{YC}$ = .114 | $R_{Y \cdot ABC}$ =.477 | .227 | .000 | .32 | .572 |
| SAT-M | $r_{YD}$ = .204 | $R_{Y \cdot ABCD}$ =.477 | .227 | .000 | .42 | .519 |
| HSR | $r_{YE}$ = .161 | $R_{Y \cdot ABCDE}$ =.477 | .227 | .000 | .20 | .964 |

Predicted Retention = .2143 ENG/GPA + 1.13.

$R_{Y \cdot A}$ = .476; Standard Error of Estimate = .42. (58% increase in forecasting efficiency over entry measures alone as predictors.)

Table 14

Comparison of Five Variables, Singly and in Combination, as Predictors of Retention for 236 Female Freshman Engineering Students Who Entered U.T. Austin in the Fall Semesters of 1974-1977

Y (Criterion Variable to be Predicted): Retention

| Predictor Variable | r<br>Correlation Coefficient (One predictor variable only) | R<br>Multiple Correlation Coefficient (Set of predictor variables) | $R^2$<br>Square of Multiple Correlation Coefficient | $R^2$ Change<br>Increase with addition of next predictor variable | F-Ratio<br>To test significance of increase in R | p<br>Statistical Significance of Increase (Level of Confidence) |
|---|---|---|---|---|---|---|
| ENG/GPA | $r_{YA}$ = .201 | $R_{Y.A}$ =.201 | .040 | .040 | 9.77 | .002 |
| Math I | $r_{YB}$ = .198 | $R_{Y.AB}$ =.229 | .052 | .012 | 2.96 | .087 |
| SAT-V | $r_{YC}$ = .019 | $R_{Y.ABC}$ =.262 | .068 | .016 | 3.98 | .057 |
| SAT-M | $r_{YD}$ = .106 | $R_{Y.ABCD}$ =.267 | .071 | .003 | .69 | .408 |
| HSR | $r_{YE}$ = .114 | $R_{Y.ABCDE}$ =.271 | .073 | .002 | .52 | .470 |

Predicted Retention = .0927 ENG/GPA + 1.35.

$R_{Y.A}$ = .201; Standard Error of Estimate = .48. (53% increase in forecasting efficiency over entry measures alone as predictors.)

Table 15
Comparison of Five Variables, Singly and in Combination, as Predictors of Retention for 91 Black Freshman Engineering Students Who Entered U.T. Austin in the Fall Semesters of 1974-1977

Y (Criterion Variable to be Predicted): Retention

| Predictor Variable | r<br>Correlation Coefficient (One predictor variable only) | R<br>Multiple Correlation Coefficient (Set of predictor variables) | $R^2$<br>Square of Multiple Correlation Coefficient | $R^2$ Change<br>Increase with addition of next predictor variable | F-Ratio<br>To test significance of increase in R | p<br>Statistical Significance of Increase (Level of Confidence) |
|---|---|---|---|---|---|---|
| FYR/GPA | $r_{YA}$ = .402 | $R_{Y \cdot A}$ =.402 | .162 | .162 | 17.14 | <.001 |
| SAT-V | $r_{YB}$ = .081 | $R_{Y \cdot AB}$ =.407 | .166 | .004 | .45 | .504 |
| HSR | $r_{YC}$ = .191 | $R_{Y \cdot ABC}$ =.410 | .168 | .002 | .25 | .621 |
| SAT-M | $r_{YD}$ = .135 | $R_{Y \cdot ABCD}$ =.411 | .169 | .001 | .05 | .831 |
| Math I | $r_{YE}$ = .172 | $R_{Y \cdot ABCDE}$ =.411 | .169 | .000 | .0008 | .976 |

Predicted Retention = .2386 FYR/GPA + 1.04.

$R_{Y \cdot A}$ = .402; Standard Error of Estimate = .47. (55% increase in forecasting efficiency over entry measures alone as predictors.)

Table 16

Comparison of Five Variables, Singly and in Combination, as Predictors of Retention for 195 Mexican-American Freshman Engineering Students Who Entered U.T. Austin in the Fall Semesters of 1974-1977

Y (Criterion Variable to be Predicted): Retention

| Predictor Variable | r<br>Correlation Coefficient (One predictor variable only) | R<br>Multiple Correlation Coefficient (Set of predictor variables) | $R^2$<br>Square of Multiple Correlation Coefficient | $R^2$ Change<br>Increase with addition of next predictor variable | F-Ratio<br>To test significance of increase in R | p<br>Statistical Significance of Increase (Level of Confidence) |
|---|---|---|---|---|---|---|
| FYR/GPA | $r_{YA} = .456$ | $R_{Y \cdot A} = .456$ | .208 | .208 | 50.75 | <.001 |
| SAT-M | $r_{YB} = .158$ | $R_{Y \cdot AB} = .458$ | .210 | .002 | .35 | .556 |
| SAT-V | $r_{YC} = .045$ | $R_{Y \cdot ABC} = .458$ | .210 | .000 | .13 | .720 |
| Math I | $r_{YD} = .162$ | $R_{Y \cdot ABCD} = .458$ | .210 | .000 | .03 | .874 |
| HSR | $r_{YE} = .123$ | $R_{Y \cdot ABCDE} = .458$ | .210 | .000 | .03 | .872 |

Predicted Retention = .2637 FYR/GPA + .94.

$R_{Y \cdot A}$ = .456; Standard Error of Estimate = .45. (55% increase in forecasting efficiency over entry measures alone as predictors.)

Table 17

Comparison of Five Variables, Singly and in Combination, as Predictors of Retention for 1,448 Anglo Freshman Engineering Students Who Entered U.T. Austin in the Fall Semesters of 1974-1977

Y (Criterion Variable to be Predicted): Retention

| Predictor Variable | r<br>Correlation Coefficient (One predictor variable only) | R<br>Multiple Correlation Coefficient (Set of predictor variables) | $R^2$<br>Square of Multiple Correlation Coefficient | $R^2$ Change<br>Increase with addition of next predictor variable | F-Ratio<br>To test significance of increase in R | p<br>Statistical Significance of Increase (Level of Confidence) |
|---|---|---|---|---|---|---|
| FYR/GPA | $r_{YA}$ = .398 | $R_{Y \cdot A}$ =.398 | .158 | .158 | 272.19 | <.001 |
| SAT-V | $r_{YB}$ = .084 | $R_{Y \cdot AB}$ =.403 | .162 | .004 | 6.23 | .013 |
| Math I | $r_{YC}$ = .225 | $R_{Y \cdot ABC}$ =.407* | .166* | .004 | 7.33 | .007 |
| HSR | $r_{YD}$ = .168 | $R_{Y \cdot ABCD}$ =.408 | .167 | .001 | .50 | .479 |
| SAT-M | $r_{YE}$ = .178 | $R_{Y \cdot ABCDE}$ =.408 | .167 | .000 | .01 | .915 |

Predicted Retention = .2116 FYR/GPA - .0005 SAT-V + .0004 Math I + 1.08.

$R_{Y \cdot ABC}$ = .408; Standard Error of Estimate = .44. (58% increase in forecasting efficiency over entry measures alone as predictors.)

*Correction for R bias, R = .406; $R^2$ = .165

Table 18

Comparison of Five Variables, Singly and in Combination, as Predictors of Retention for 1,525 Male Freshman Engineering Students Who Entered U.T. Austin in the Fall Semesters of 1974-1977

Y (Criterion Variable to be Predicted): Retention

| Predictor Variable | r<br>Correlation Coefficient (One predictor variable only) | R<br>Multiple Correlation Coefficient (Set of predictor variables) | $R^2$<br>Square of Multiple Correlation Coefficient | $R^2$ Change<br>Increase with addition of next predictor variable | F-Ratio<br>To test significance of increase in R | p<br>Statistical Significance of Increase (Level of Confidence) |
|---|---|---|---|---|---|---|
| FYR/GPA | $r_{YA}$ = .449 | $R_{Y \cdot A}$ =.449 | .201 | .201 | 383.64 | <.001 |
| SAT-V | $r_{YB}$ = .117 | $R_{Y \cdot AB}$ =.450 | .202 | .001 | 2.31 | .129 |
| SAT-M | $r_{YC}$ = .208 | $R_{Y \cdot ABC}$ =.451 | .204 | .001 | 2.14 | .144 |
| Math I | $r_{YD}$ = .237 | $R_{Y \cdot ABCD}$ =.451 | .204 | .000 | .36 | .548 |
| HSR | $r_{YE}$ = .162 | $R_{Y \cdot ABCDE}$ =.452 | .204 | .000 | .23 | .635 |

Predicted Retention = .2403 FYR/GPA + 1.03.

$R_{Y \cdot A}$ = .449; Standard Error of Estimate = .43. (58% increase in forecasting efficiency over entry measures alone as predictors.)

Table 19

Comparison of Five Variables, Singly and in Combination, as Predictors of Retention for 235 Female Freshman Engineering Students Who Entered U.T. Austin in the Fall Semesters of 1974-1977

Y (Criterion Variable to be Predicted): Retention

| Predictor Variable | r<br>Correlation Coefficient (One predictor variable only) | R<br>Multiple Correlation Coefficient (Set of predictor variables) | $R^2$<br>Square of Multiple Correlation Coefficient | $R^2$ Change<br>Increase with addition of next predictor variable | F-Ratio<br>To test significance of increase in R | p<br>Statistical Significance of Increase (Level of Confidence) |
|---|---|---|---|---|---|---|
| Math I | $r_{YA}$ = .203 | $R_{Y \cdot A}$ =.203 | .041 | .041 | 9.98 | .002 |
| SAT-V | $r_{YB}$ = .015 | $R_{Y \cdot AB}$ =.238 | .057 | .016 | 3.85 | .051 |
| FYR/GPA | $r_{YC}$ = .199 | $R_{Y \cdot ABC}$ =.273* | .075* | .018 | 4.46 | .036 |
| HSR | $r_{YD}$ = .121 | $R_{Y \cdot ABCD}$ =.276 | .076 | .002 | .39 | .534 |
| SAT-M | $r_{YE}$ = .115 | $R_{Y \cdot ABCDE}$ =.277 | .077 | .001 | .21 | .646 |

Predicted Retention = .0013 Math I - .0009 SAT-V + .0875 FYR/GPA + 1.06.

$R_{Y \cdot ABC}$ = .273; Standard Error of Estimate = .48. (54% increase in forecasting efficiency over entry measures alone as predictors.)

*Correction for R bias, R = .259; $R^2$ = .067

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